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City Document.—No. 6.

REPORT

PRESENTED TO

THE SCHOOL COMMITTEE

ON THE

VENTILATION

OF THE

SCHOOL HOUSES

OF THE

CITY OF BOSTON.



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CITY OF BOSTON.

In School Committee, December 30, 1846.

The Report of the Committee on Ventilation was laid upon the table, and five hundred copies ordered to be printed, with the drawings; and the Committee were authorized to make such additions to their Report as they might deem expedient.

Attest, S. F. McCLEARY, *Secretary.*

In School Committee, December 30, 1846.

Ordered, That the Committee on Ventilation be and hereby are directed to adapt to each School-room of the Common Schools such apparatus, if any, as may be required to secure to them proper ventilation in Winter and Summer, and make such alterations and arrangements of the furnaces as may be required.

Attest, S. F. McCLEARY, *Secretary.*

CITY OF BOSTON.

In School Committee, February 4, 1846.

Ordered, That Messrs. Clark, Loring, and Brooks, be a Committee, to consider the subject of Ventilation of the Schoolhouses, under the care of this Board, and to report, at a future meeting, some method of remedying the very defective manner in which it is now accomplished.

And said Committee are authorized to ventilate, as a matter of experiment, any three Schoolhouses, in such manner as they may deem expedient.

Attest, S. F. McCLEARY, *Secretary*.

The Committee, to whom the subject of Ventilation was referred, ask leave to

R E P O R T :

That, during the early part of the present year, they have visited, and carefully examined, all the Schoolhouses under the care of this Board, in obedience to the Order herewith prefixed.

The discontinuance of fires, during the warm season, interrupted, in a great measure, the experiments it was thought expedient to institute; and, in order to complete them, it has been found necessary to delay this Report to the present time.

Your Committee do not deem it advisable or necessary, to enter upon the discussion or description of the various systems of ventilation which have been proposed or adopted, from time to time, or to consider their comparative merits. Many of them, no doubt, are excellent; and, if properly arranged, must be efficient. But we believe, that the distinguishing excellence of any method must consist in, and be in exact ratio to, its adaptedness to meet the peculiar requirements of each case to which it is applied. Nor do we think it possible for any plan to succeed, which does not include the architecture and situation of the structure to be ventilated, and the number and necessities of those who are to occupy it. Nevertheless, a suitable attention to the laws of life, and of the physical agents which are concerned with it, will always ensure ready indications of the best course of procedure, and, at the same time, furnish a basis whereon to found it, which will be sufficiently firm and comprehensive. Your Committee, therefore, desire to call the attention of this Board, chiefly to the consideration of such general and well-established Physiological and Philosophical principles, as have a distinct and intimate relation to the subject of this Report, and may be useful in its elucidation.

In doing this, there are two things of which they hope to satisfy the Board.

First. The necessity of a system of Ventilation, which shall furnish, for all the pupils in the Public Schools of Boston, at all times, an abundant supply of an atmosphere entirely adapted, in its purity and temperature, to the purposes of respiration.

Secondly. The entire failure of the measures heretofore adopted to accomplish this desirable end.

The function of Respiration, is that process, by whose agency and constant operation, atmospheric air is admitted to the internal surface of the lungs, and there brought into close contact with the blood, for the purpose of effecting certain changes in it, which are essential to the continuance of life, and to maintain the integrity of the bodily organs. During this process, the atmosphere is constantly losing its oxygen, which is carried into the circulation, while, at the same time, it is becoming overcharged with the carbonic acid gas, which is continually thrown off from the lungs by respiration. This effete and deadly poison spreads itself rapidly into all parts of the room.

“M. Lassaigue has shown, by a series of investigations, that, contrary to a common opinion, the air, in a room which has served for respiration without being renewed, contains carbonic acid alike in every part, above as well as below; the difference in proportion is but slight; and, where appreciable, there is some reason to believe that the carbonic acid is in greater quantity in the upper parts of the room. These experiments establish the very important fact, that all the air of a room must be changed, in order to restore its purity.”*

Dr. Wyman makes the following remarks on this point: “Although carbonic acid is a much heavier gas than atmospheric air, it does not, from this cause, fall to the floor, but is equally diffused through the room. If the gas is formed on the floor, with-

* Silliman's Journal, for September, 1846.

out change of temperature, this diffusion may not take place rapidly. In the celebrated *Grotto del Cane*, carbonic acid escapes from the floor, and rises to a certain height, which is pretty well defined to the sight on the walls; below this line, a dog is destroyed, as if in water; above it, he is not affected. An analysis of the air above and below a brazier has been made, and it was found equally contaminated, —the former containing 4.65 per cent., and the latter 4.5 per cent. of carbonic acid.

“From the experiments of M. Devergie, who has devoted much attention to the poisonous effects of these gasses, it appears, that the heat disengaged from the combustion of charcoal, produces an equal mixture at all elevations in the apartment; and this state of things continues *as long as the room remains warm*; but after twelve hours or more, the carbonic acid sinks, and while that near the ceiling contains only a seventy-eighth, that near the floor contains nearly four times as much, or a nineteenth.”*

If further proof be needed, to establish this position, we have other testimony. During respiration, a considerable quantity of vapor is discharged from the lungs. With regard to this, Mr. Tredgold says: “if the air did not contain this mixture of vapor, it would not rise when expelled; and we have to admire one of those simple and beautiful arrangements, by which our all-wise Creator has provided against the repeated inhalation of the same air; for a mixture of azote, carbonic acid gas, and vapor, at the temperature it is ejected, is much lighter than common air even at the same temperature. Hence,

* Practical Treatise on Ventilation, p. 77.

it rises with such velocity, that it is entirely removed from us before it becomes diffused in the atmosphere. But as all gaseous bodies and vapors intimately mix when suffered to remain in contact, we see how important it is that ventilation should be continual ; that the noxious gasses should be expelled as soon as generated ; and that the ventilation should be from the upper part of a room.”*

If, to the foul effluvia ejected from the lungs, and accumulating in an apartment as badly ventilated as one of our Schoolrooms, be added, the fouler matter thrown into the air from the insensible perspiration of so many individuals, many of whom are of uncleanly habits in person and apparel, it is apparent, that, in a very limited period of time, the air, in a perfectly close room, would become so entirely unfit for respiration, that, to all who were exposed to its influence, submersion in water could not be more certainly fatal.

The terrible effects of continued exposure to carbonic acid gas in a concentrated form, have been graphically described by Howard, in his account of the Black Hole of Calcutta. Of one hundred and forty-six persons, shut up in this place, for only ten hours, without any other means of ventilation than one small opening, but twenty-six were found alive, when it came to be opened ; and most of these suffered afterwards from malignant fevers.

The fainting of feeble persons, in crowded assemblies, and the asphyxia, so often produced in those who descend into deep wells without suitable pre-

* Tredgold on Warming and Ventilating Buildings, p. 70.

caution, are familiar examples of the same noxious effects of this poison.

It has been usually estimated, that every individual, by respiration, and the various exhalations from the body, consumes or renders unfit for use, at least from four to five cubic feet of air per minute. This is probably a low estimate; but authors of good repute differ considerably on this point. Mr. Tredgold's remarks, in this connection, are interesting and pertinent. "The Physiological Chemists," says he, "have placed in our hands a more accurate means of measuring the deterioration of air in dwelling-rooms, than by the best eudiometer; for they have shown, by repeated experiments on respiration, that a man consumes about thirty-two cubic inches of oxygen in a minute, which is replaced by an equal bulk of carbonic acid from the lungs. Now, the quantity of oxygen in atmospheric air is about one fifth; hence it will be found, that the quantity rendered unfit for supporting either combustion or animal life, by one man, in one minute, is nearly one hundred and sixty cubic inches, by respiration only. But a man makes twenty respirations in a minute, and draws in and expels forty inches of air at each respiration; consequently, the total quantity contaminated in one minute, by passing through the lungs, is eight hundred cubic inches."* The other sources of impurity, which should be considered, will increase the estimate to the amount above stated. The amount of vapor discharged from the lungs, and thus added to the impurities of the air, is said to exceed six grains per minute. It has also been shown,

* Tredgold on Warming and Ventilating Buildings, p. 69.

that air, which has been some time in contact with the skin, becomes almost entirely converted into carbonic acid.*

In estimating the amount of fresh air to be supplied, we ought not merely to look at what the system will tolerate, but that amount which will sustain the highest state of health for the longest time. Dr. Reid recommends at least ten cubic feet per minute, as a suitable average supply for each individual; and states that his estimate is the result of an "extreme variety of experiments, made on hundreds of different constitutions, supplied one by one with given amounts of air, and also in numerous assemblies and meetings, where there were means for estimating the quantity of air with which they were provided."†

These calculations refer to adults; but the greater delicacy of the organization of children, and their feebler ability to resist the action of deleterious agents, together with their greater rapidity of respiration, demand for them at least an equal supply. Proceeding upon this basis, and multiplying the amount required per minute, by the minutes of a school session of three hours, we have eighteen hundred cubic feet for each pupil, and for two hundred and fifty pupils—the average maximum attendance in one of our large school-rooms,—450,000 cubic feet, as the requisite quantity for each half-day. The rooms contain about 22,500 cubic feet only: so that a volume of air, equal to the whole cubic contents of each room, should be supplied and removed, in some way, ten times every three hours, in order to sustain the atmosphere in them at

* Cruikshanks makes it twenty-three grains per minute.

† Illustrations of Ventilation, p. 176.

a point which is perfectly wholesome and salubrious. For such a purpose, the present means are so entirely inadequate, that it was found that the air of a room became tainted in ten or fifteen minutes. In ordinary cases, four per cent. of the air expelled from the lungs is carbonic acid. The presence of five or six per cent. will extinguish a lamp, and with difficulty support life. It is therefore certain, that the air would become deprived of all its best properties in one school session.

Le Blanc,—who examined many public and private buildings, in France and elsewhere,—speaking of the Chamber of Deputies, where sixty-four cubic feet of fresh air *per hour*, or one foot and a fraction per minute, were allowed to each individual, states, that of 10,000 parts escaping by the ventilator, twenty-five were carbonic acid; while the quantity of this gas ordinarily present, in the atmosphere, is but $\frac{4}{1000}$.* Dr. Reid states, that he never gave less than thirty cubic feet of air a minute, to each member of the House of Commons, when the room was crowded; and once he introduced, for weeks successively, sixty cubic feet a minute, to each member.

The very earliest impressions received by your Committee, in their visits to the schoolhouses, satisfied them of their lamentable condition in regard to ventilation. In some of them, they found the air so bad, that it could be perceived before reaching the schoolrooms, and in the open entries; and the children, as they passed up and down the stairs, had their clothes and hair perceptibly impregnated with the fœtid poison. And these circumstances exist-

* Treatise on Ventilation, p. 183.

ed in houses, where the open windows testified, upon our entrance, that the Masters had endeavored to improve the atmosphere by all the means placed at their disposal. To this custom,—*that of opening windows in school hours*,—the Instructors are compelled to resort, for relief; and this expedient, certainly is the lesser of two very great evils. Your Committee found in their visits to the schoolhouses, during the severest days of last Winter, that no schoolroom had less than three, and that more than half of them had at least seven windows open for the admission of pure air. Yet this dangerous and injurious practice only mitigates the evils of bad air, by creating others. It produces colds and inflammatory complaints, and the air still remains impure, offensive, and highly deleterious; sufficiently so, to affect the delicate organization of childhood, to blight its elasticity, and destroy that healthful physical action, on which depends the vigor of maturer years.

We have already referred to some of the more violent and sudden effects of exposure to air highly charged with these noxious gasses. There are others, which are more remote, and, to a superficial observer, less noticeable. But they are not, therefore, of less importance. The grave consequences of a long-continued exposure to an atmosphere but a little below the standard of natural purity, although not immediately incompatible with life, can hardly be overstated. These effects are often so insidious in their approach, as hardly to attract notice; they are therefore the more necessary to be provided against in advance.

Children, confined in the atmosphere of these schools, soon lose the ruddy and cheerful complex-

ions of perfect health which belong to youth, and acquire the sallow and depressed countenances which might reasonably be expected in over-worked factory operatives, or the tenants of apartments unvisited by the sun or air. We noticed in many faces, also, particularly towards the close of a school session, a feverish flush, so bright that it might easily deceive an inexperienced eye, and be mistaken for a healthy bloom. Alas! it was only a transient and ineffectual effort of nature to produce, by *overaction*, those salutary changes which she really wanted the *power* to accomplish.

The condition of the pupils, depressed as they are by these influences, is constantly demanding increased exertions from their Instructors, while the requirements of the age, place the standard of education at an elevation sufficiently difficult of access under the most favorable circumstances.

Your Committee are satisfied, therefore, that the present state of the schoolhouses daily impairs the health of the pupils and Instructors, and the efficiency of the schools for the purposes of instruction. That its continuance will produce, not only immediate discomfort and disease, but, by its effect on the constitutions of the children, who must pass in them a large portion of those years most susceptible to physical injury, will directly and certainly reduce the amount of constitutional vigor hereafter to be possessed by that large mass of our population, which now and hereafter is to receive its education in these schools.

Although the atmosphere in the different schoolhouses varied very much in particular cases, either owing to the time of the visits, or from the amount

of attention and intelligence of the Masters, yet in in none of them was it at all satisfactory; not one of them was furnished with any useful or systematic means of ventilation. Every one, in order to be kept in a tolerably comfortable condition in this respect, required the frequent and laborious attention of the Instructors, and often to a degree which must have seriously interfered with their legitimate duties.

All of the rooms are provided with registers, in or near the ceiling, ostensibly for the purpose of discharging the foul air, but which your Committee believe to be almost entirely useless. The openings through the roof into the open air, where they exist,* are so small, as to be quite inadequate to relieve the attics; so that the bad air must accumulate there, and, after becoming condensed, be gradually forced back again, to be breathed over by the same lungs which have already rejected it. The condition of the apartments, after undergoing a repetition of such a process, for any length of time, can easily be imagined.†

It may be a matter of surprise, to some, perhaps, that the subject of ventilating our schoolrooms has not long ago received the consideration necessary to remedy, or even to have prevented altogether, the evils of which we at present complain. But these evils have not always existed. It should be recollected, that the stoves and furnaces now in common use, are of comparatively modern date; and moreover, that the ample fireplaces, which they have displaced, always proved perfectly efficient ventilators, although, it is true, somewhat at the

* In one house at least, there were none at all!

† See Diagram, p. 15.

expense of comfort and fuel. But in closing the fireplaces, and substituting more economical methods of warming, evils of far greater magnitude have been entailed upon us.

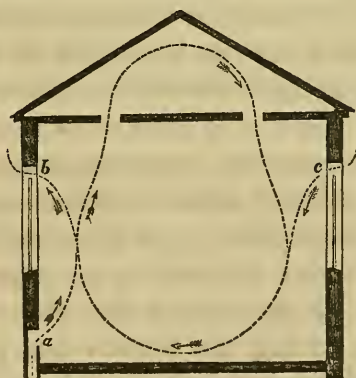
It is evident, that, in order to carry into operation any complete system of ventilation, there must be connected with it some apparatus to regulate the temperature of the air to be admitted, as well as to ensure its ample supply. Your Committee have accordingly examined, with much care, this part of the subject. A majority of the buildings are furnished with "hot-air furnaces," situated in the cellars; the remainder with stoves, placed in the schoolrooms themselves.

In our endeavors to introduce in this department, the improvements which seemed to us absolutely essential, we have encountered serious difficulties. Most of the furnaces possess great heating powers,—indeed much greater than are necessary, if the heat generated by them were properly economized, or could be made available;—but, as now constructed, they are almost worse than useless, consuming large quantities of fuel, and, at the same time, so overheating the air which passes through them, as to deprive it of some of its best qualities, and render it unsuitable for respiration. It is difficult to define, with precision, and by analysis, the changes which take place in air subjected to the action of metallic surfaces, at a high temperature. The unpleasant dryness of the air can be detected, very readily, by the senses; and the headache, and other unpleasant sensations, experienced by those who breathe such an atmosphere, would seem to prove a deficiency of oxygen and electricity. The rapid oxydation and destruction of the ironwork of the furna-

ces themselves, also tends to confirm this supposition.

It has been ascertained, by repeated examinations, that the temperature of the air, when it arrives at the rooms, is often as high as 500° and 600° Fahrenheit.* Of course, it is entirely impossible to diffuse air, thus heated, in the parts of the room occupied by the pupils. Much of it passes rapidly out of the windows, which may be open; the rest to the ceiling, where it remains until partially cooled, gradually finding its way down by the walls and closed windows, to the lower parts of the room. The consequences are, that, while much more caloric is sent into the apartment than is requisite, many of the pupils are compelled to remain in an atmosphere which is at once cold and stagnant.

A reference to the subjoined diagram will explain at once, the present state of the Ventilation of the Schoolhouses.



- a. Heated air from furnace.
- b. Hot air escaping through open window.
- c. Cold air entering through open window.

* However great the excess of heat may be, at any time, the occupants of the rooms are compelled to receive it, as there are no registers or dampers by which it can be regulated.

These difficulties are to be attributed to the structure of the furnaces; and they cannot well be obviated, by any other method than by rebuilding or replacing them. The same statement, in a degree, will apply to the stoves, also, as they are, in fact, portable or miniature furnaces, being supplied with small "cold air" chambers, and connected with the external atmosphere.

The source of the cold air for supplying the furnaces, is not always free from objection; some being drawn from the neighborhood of drains, cess-pools, &c. This is a radical defect, as it must inevitably affect the whole air of the building. The boxes, which admit the cold air to the furnaces, are much too contracted; some of them being only a few inches square, when their capacity ought to be nearly as many feet. The air enters the "cold air" chamber of the furnace, at its top, whence it is intended to be carried down between thin brick walls, (which *should be cold*, but which are often heated to 300° Fahrenheit,) to the lower part of the furnace, and thence into the "hot-air" chambers, and so on to the rooms above. It is obvious that the "hot-air" chamber must be heated to a temperature far beyond that of the "cold-air" chamber, in order to compel the air, against its own natural tendencies, to pass into it with any velocity or volume, and the very attempt to accomplish this, almost defeats itself; as, by driving the fire for this purpose, the "cold-air" chamber becomes still hotter, so that at last the contest is decided only by the greater calorific capabilities which the iron plates possess over the brick wall. At any rate, the temperature of the iron, is frequently raised to a *red* and even a *white*

heat, by running the furnaces in the ordinary way. This soon destroys them, and they require consequently to be frequently renewed. In addition to all this waste of fuel and material, the folly of attempting, in any way, to warm schoolrooms whose windows are freely opened to the admission of an atmosphere, at the low temperature of our winter climate, may well claim a passing notice.

With regard to the expenditure necessary to complete the improvements which your Committee recommend, they are of the opinion, that the alarming evils referred to in this Report, may be at once, and entirely and permanently removed, at an average expense of two hundred and fifty dollars* for each schoolhouse, now built. And by availing ourselves of some recent improvements, which have been made in this City, in the form and construction of a part of the necessary apparatus, we hope to reduce its cost, and at the same time increase its efficiency.

But the Committee have no doubt, from actual experience of the effects already produced by the experiments which they have superintended, in two schoolhouses, that all the expense of any alterations which may be required, to warm and ventilate our schoolhouses upon rational principles, and in a thorough manner, will be more than saved to the City, in two or three years, in the item of fuel, alone, if the system which they propose is adopted, and faithfully carried into operation.

Your Committee wish to remark here, in passing, that no system of artificial ventilation, however excellent, can give an atmosphere, equal to

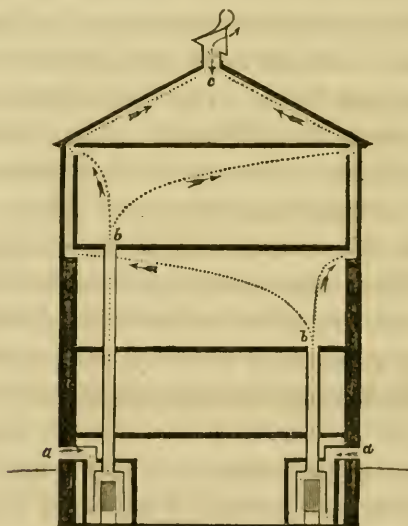
* Or, about 50 cents only for each pupil, and to be paid but once.

that of nature ; they therefore recommend that the pupils should be sent into the open air, *at least as often as once in every hour.*

The following diagrams will exhibit the mode in which the two houses already referred to, are now ventilated.

The Eliot Schoolhouse. This house was entirely without any external opening through the roof. The other arrangements in it presented nothing peculiar. The "exits and the entrances" were

Plan of the Ventilation of the Eliot Schoolhouse.



a. a. Cold air channels to furnaces.

b. b. Heated air.

The arrows show the currents of air from the furnaces to the outlet at the roof.

c. Gas burner.

all as deficient in capacity as usual. The first care was to perforate the roof. This was accordingly done, and an opening of sufficient size made to carry a turn-cap of two and a half feet in diame-

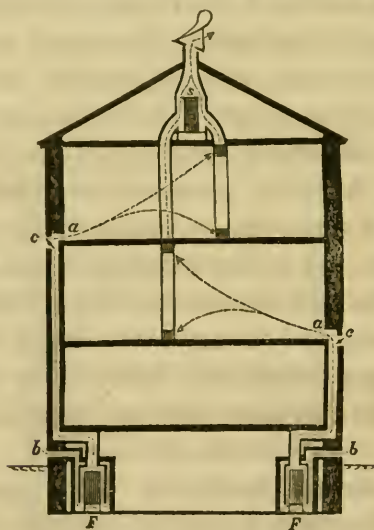
ter in its smallest part. The cold-air shaft, with an area of only one hundred and forty square inches, was enlarged so as to measure six hundred, or about four times its former size. The necessary repairing of one furnace, gave us an opportunity to enlarge its air-chamber very considerably. Water, for evaporation, was placed within a chamber of the furnace. The registers in the rooms opening into the attic, being below the ceiling, were raised to the highest point, and increased in size.

Although we think the want of connection of the cowl at the roof with the registers from the rooms by closed tubes, a decided disadvantage, we were satisfied, on the whole, with the results; as the alterations gave great relief. These changes were made during the month of February of the present year, 1846, and the only inconvenience suffered during the Winter, was the occasional rise of the temperature to five or ten degrees beyond the desired point. The atmosphere has lost its bad odour almost entirely, and is of course much more agreeable. A gas burner, has lately been placed in the throat of the ventilator, for use when extra power is needed.

The Endicott Schoolhouse. This house, as well as the preceding, was heated by furnaces in the cellar, one for each room. Its ventilating flues were arranged in a better manner than usual, opening into little separate chimneys which pierced the roof near the copings. But they had proved to be insufficient, both on account of their size and situation. They were also affected sensibly by down-gusts, which completely reversed their action in certain states of the atmosphere and wind.

After enlarging the cold-air shaft to a proper size, it was thought best, (as the hot-air pipe passed through the brick wall, so that it could not easily be altered,) to make an opening through the outer wall directly behind the register which delivered the hot-air into the room. An aperture of sixteen inches square, commanded by a revolving damper, was therefore cut. It has been found to answer exceedingly well; as we now get a much larger volume, of more temperate and purer air.

Plan of the Ventilation of the Endicott Schoolhouse.



- a. a. Currents of heated air passing to the ventilating flues.
- b. b. Cold air channels.
- c. c. Cold air valves opening upon the hot-air currents.
- F. F. Furnaces.
- S. Stove in ventilator in the attic.

For the delivery of the bad air, the following arrangements were adopted. Large wooden boxes, or air-shafts, were carried from the floor of each story into the attic, where they communicate, by

closed metal pipes of the same size, with a tin cylinder, three feet in diameter, which is continued to the roof, terminating there in a large cowl. There are openings, at the top and bottom of each room, into the ventilating shafts, which can be used separately, or together, as the state of the atmosphere requires.

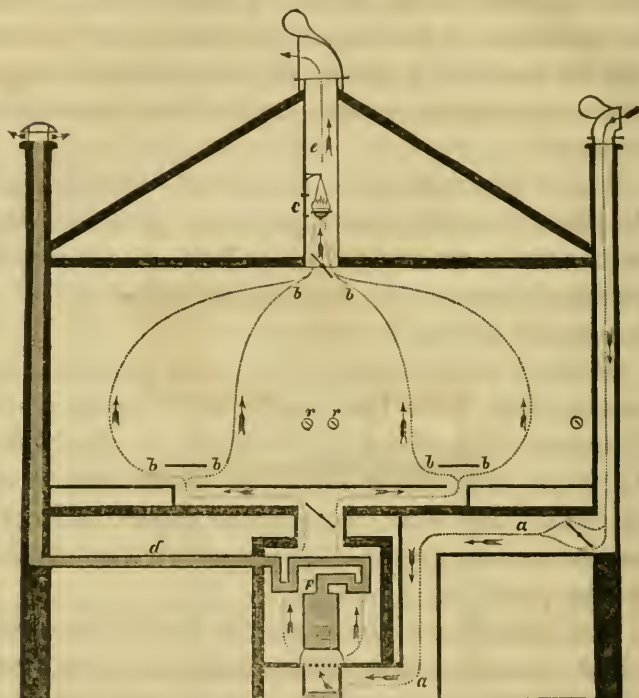
An air-tight coal stove, placed within the drum, in the attic, completes the apparatus. This has been only recently constructed; but from results already produced, there is no doubt of its entire ability to accomplish all that is desirable.

Primary Schoolhouses. The same general statements which have been made with regard to the Grammar Schoolhouses, will apply to these also. They are undoubtedly in as bad a condition, to say the least; and from their smaller capacities in proportion to the number of pupils which they contain, require particular attention.

For ventilation of these, and the Recitation rooms, which resemble them in structure and size, your Committee recommend the use of the double fireplace or the stove described on page 23. If the latter be used, ventilating flues, opening at the ceiling, must be carried out of the roof.

It only remains for your Committee to describe, more particularly, the system of ventilation which they consider to be, in its general features, best adapted for the schoolhouses under the care of the Board. Much of it has already been anticipated in other parts of this Report; and the following plan will show, at a glance, better than any description can do, its particular features.

Diagram showing the best general plan for warming and ventilating the Grammar Schoolhouses.



a. a. Cold-air channel, three feet in diameter, opening underneath the Furnace.

F. Furnace, three feet in diameter in a brick chamber ten feet square. The walls twelve inches thick.

d. Smoke flue, surmounted with Mr. Tredgold's chimney top.

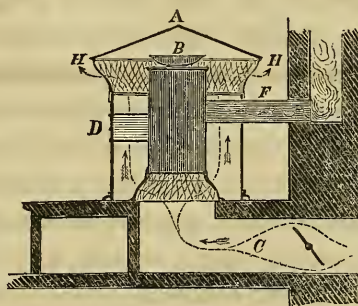
b. b. b. b. Currents of warmed air, passing from the furnace, through a main flue of four feet in diameter, which supplies two branch flues. From these the air is diffused into all parts of the room, by means of the tablets which are placed over the mouths of the registers.

e. The ventilating shaft, two and a half feet in diameter, into which the foul gasses are collected, and from which they are finally discharged into the open air.

c. An Argand Lamp, to be lighted from the attic.

r. r. r. Registers, by means of which the whole circulation is controlled.

The drawing beneath exhibits a section of a stove, enclosed by an outward casing of sheet iron, or tin, so as to make a large chamber around it, into which the fresh air may be admitted and warmed. This is a good method of warming recitation rooms or the large rooms which are now supplied with stoves.



A. A flattened cone of sheet iron suspended over the stove to give a lateral direction to the warm air, as it escapes through the wire gauze at H. H.

B. Vase for water. D. Door to fire. F. Smoke flue, and C. Cold-air box, opening under the stove.

The Committee recommend attention to the following *general rules for Ventilation and Warming*.

1. The air must be taken from a pure source. The higher parts of the building are the best, as thereby all impurities, which often contaminate air taken from near the surface of the ground, are avoided.

2. In order to ensure a constant and abundant supply, the air shaft must be surmounted with a cowl or hood of some kind, with its mouth turned *towards the wind*.

3. The fresh air should in all cases be carried entirely beneath the furnace. If the cellar is wet

and the situation low, the underground culvert or channel, should be of brick, laid in cement.

4. The furnace chamber should be so large that it can be entered at any time, without the necessity of taking down walls, for the purpose of repairs, or to observe the temperature. A large earthen pan for the evaporation of water should never be omitted. This should be kept always perfectly clean, and the water required to be frequently changed.

5. A thermometer should be constantly at hand and the *temperature in the warm-air chamber should never be allowed to exceed that of boiling water*. A still lower temperature is often desirable. If this point is secured, the hot air can be conducted with perfect safety under floors, or into any part of the building for its better diffusion.

6. The openings for the admission of the warm air into the rooms, should be as numerous as possible. The long platform occupied by the teachers, by being perforated in front for its whole length, would be an excellent diffusing surface.

7. Openings of ample size must be made in the highest points of the ceiling, to be connected at the top of the roof with a turn-cap or louvre, the former being always surmounted with a vane. It is better that the ceiling should be perforated at its centre, and there is no objection to running the ventilating shaft, at first, horizontally, if the perpendicular and terminal portion of it is of considerable length.

8. *It is highly important to have a power of some sort, within the apparatus at its top, for the purpose of compelling constant action and of increasing the force of the apparatus, whenever the state of the*

weather, or the crowding of the room, render it necessary. For this purpose, the most convenient and economical means are furnished by a gas burner, an argand lamp, or a stove; and one of these should be in constant readiness for use, when neither the velocity of the wind, or the low temperature of the external atmosphere are sufficient to produce the desired effect.

9. All the openings and flues for the admission of pure air, and the discharge of the foul air, should be of the *maximum* size; that is they should be calculated for the *largest numbers* which the apartment is ever intended to accommodate.

10. Valves must be placed in all the flues, and so arranged as to be easily regulated without leaving the rooms into which they open.

11. The best average temperature for school-rooms, is from 64° to 68° Fahrenheit; this range including that of the healthiest climates in their best seasons.

For the purpose of summer ventilation, and for occasional use in moderate weather, fireplaces of good size, should be constructed in all the new houses, at least. They should always be double, and furnished with large air chambers, which communicate with the open air. When not in use, they must be closed with tight boards or shutters, as they would otherwise interfere with the regular ventilation.

With these arrangements, intelligently controlled by the Teachers, your Committee believe, that an atmosphere will be secured, which will be perfectly agreeable and salubrious; which will lighten the

labors of the Teachers, and promote the comfort, health, and happiness, of the thousands of children who are daily congregated in our Public Schools.

Before concluding this Report, your Committee cannot avoid expressing the confident belief, that a suitable consideration of the evils, whose existence they have proved, is only necessary to ensure their speedy removal.

It has been already shown, that healthy blood is essential to the proper action of every organ in the body, and that the healthy condition of the blood, and even life itself, depend entirely upon the act of respiration; that, to breathe air deprived of its oxygen, or containing anything which prevents the necessary changes in the blood, is to breathe disease and death. And yet with all these facts staring us in the face, habit has reconciled us to practices, which would otherwise be noxious and disgusting. We instinctively shun approach to the dirty, the squalid, the diseased, nor use a garment that may have been worn by another; we open sewers for matters that offend the sight and smell, and contaminate the air; we carefully remove impurities from what we eat and drink, filter turbid water, and fastidiously avoid drinking from a cup that may have been pressed to the lips even of a friend. On the other hand, we resort to places of assembly, and draw into our mouths air loaded with effluvia from the lungs and skin and clothing of every individual in a promiscuous crowd; exhalations which are offensive to a certain extent from the most cleanly individuals;* but when rising from a living mass of

* Bernan. History of the Art of Warming and Ventilating.

skin and lung in all stages of evaporation and prevented by the walls and ceiling from escaping, they are, in the highest degree deleterious and loathsome.

We can subsist without food, for days, or even weeks. We might spend our whole lives, under some circumstances, without clothing or shelter ; and yet, while almost all the energies of civilized society are exerted to obtain these things, in their various forms of comfort or luxury ; with a most surprising disregard of the dictates of common sense, and a want of discretion which is no where else exhibited, we exclude from our best houses, by every means in our power, that vital fluid, without which no respiratory being can exist for a single hour.

HENRY G. CLARK,
EDWARD G. LORING,
CHARLES BROOKS.

Boston, December 30, 1846.

In School Committee, February 3, 1847.

The Committee on Ventilation, ask leave to lay before the Board, the following documents, as an additional Report.

For the Committee,

HENRY G. CLARK, *Chairman*

M E M O R I A L .

*To his Honor the Mayor and the Aldermen and the
Common Council, of the City of Boston.*

Your memorialists respectfully represent,

That they have been charged by the School Committee with the following Order,—

“CITY OF BOSTON.

In School Committee, Dec. 30, 1846.

Ordered, That the Committee on Ventilation be and hereby are directed to adapt to each school-room of the Common Schools, such apparatus, if any, as may be required to secure to them proper ventilation in summer and winter, and to make such alterations and arrangements of the Furnaces as may be required.”

That the imperfect ventilation of the Schoolhouses impairs daily the health of the instructors and pupils, and the efficiency of the Schools ; and its continued

action on the susceptible organization of childhood, must certainly and greatly reduce the amount of constitutional vigor to be hereafter possessed by that large mass of our population which is now and hereafter to receive its education in these schools.

That your memorialists have ascertained, not only by examination of the Schoolhouses and theoretical reasonings—but by actual experiments, conducted through the varying seasons of the last year—that the great evils referred to, may be at once and entirely and permanently removed.

That the cost of securing to each Schoolhouse a salubrious atmosphere, will be \$250, so that if 500 be taken as the number of the occupants of each Schoolhouse—50 cents for each, *for a single year*, will make to them, the difference, of comfort, or discomfort, of health or disease, and perhaps death,—and this estimate does not regard the generations which are to succeed the present in our Schoolhouses.

That your memorialists from the experiments instituted, are convinced that the cost as stated above, would in a few years be saved to the City, in the increased economy of warming the Schoolhouses—so that ever after the City would pecuniarily gain by the improvements proposed.

And therefore, that they may execute the order of the School Committee above set forth, they respectfully request an appropriation of Four Thousand Dollars may be made by the authorities of the City.

HENRY G. CLARK, EDWARD G. LORING, CHARLES BROOKS,	} Committee on Ventilation, by the appointment of the School Committee.
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December 31, 1846.

In Common Council, January 7, 1847.

Referred to Messrs. Perkins, Thayer, and Lincoln of Ward 10, with such as the Board of Aldermen may join.

Sent up for concurrence.

GEORGE S. HILLARD, *President.*

In the Board of Aldermen, January 11, 1847.

Concurred, and Aldermen Briggs and Wilkins were joined.

JOSIAH QUINCY, JR., *Mayor.*

The Joint Special Committee to whom was referred the petition of the Sub-Committee of the School Committee, asking an appropriation to improve the ventilation of the Grammar School Houses, have attended to the subject, and ask leave to

R E P O R T .

The petitioners appeared before the Committee, and set forth the great importance that attaches to the subject of having pure air where great numbers are congregated—especially where those masses are constituted of children. They stated that in two of the Grammar School Houses, they had caused a ventilating apparatus to be constructed, which had been in operation nearly a year.

The experience of this period authorized them to state, first, that the air of the rooms had been greatly improved,—and in the second place, that the expense of warming the rooms was diminished one half, besides a great saving in the consumption of the castings of the furnace.

Such were the representations of the petitioners.

In order to be fully satisfied, the Committee visited the Endicott School, where the apparatus was in operation. The day was exceedingly wet and disagreeable, and yet the air of the rooms was found in an unobjectionable condition. The masters fully sustained the representations of the petitioners; and from their statements, as well as from their own observations, the Committee were satisfied of the beneficial effects of said apparatus.

In order, however, to have a more full investigation of the matter, the Committee, on a subsequent day, visited the Johnson School and the Boylston School. The day was dry and cold, and they found the air in the Johnson School in a tolerably good condition. This is a girls' school; and it is well known that the pupils in such schools are neater, and attend in cleaner and more tidy apparel, than the pupils in the boys' schools.

In the Boylston School, however, the Committee found the air very disagreeable and oppressive; and they could not but feel the importance of executing some plan of relief.

From the earnest representations of the petitioners, and from the result of their own examination, the Committee are of the opinion that the prayer of the petitioners ought to be granted; and they therefore recommend the passage of the following order; all which is respectfully submitted.

BILLINGS BRIGGS, *Chairman.*

Ordered, That the sum of *Four Thousand Dollars* be appropriated for the purpose of improving the ventilation of the Grammar School Houses—the

same to be expended under the direction of the Joint Committee on Public Buildings—and be charged to the appropriation for School Houses.

In Common Council, Jan. 21, 1847.

Passed.

Sent up for concurrence.

GEO. S. HILLARD, *President.*

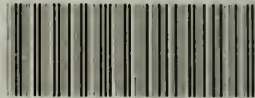
In the Board of Aldermen, Jan. 25, 1847.

Read and concurred.

JOSIAH QUINCY, JR. *Mayor.*



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